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Disease-a-Month

Low Back Pain

CARROLL B. LARSON

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Disease-a-Month Series

MONTHLY CLINICAL MONOGRAPHS ON CURRENT MEDICAL PROBLEM

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Low Back Pain

CARROLL B. LARSON

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Carroll B. Larson

received his M.D. degree from the University of Iowa and completed orthopedic training at Harvard. In 1939 he became associated with Drs. M. N. Smith-Petersen and O. E. Aufranc in Boston, where he remained until 1950. He then succeeded Dr. Arthur Steindler as Professor and Head of the Department of Orthopedic Surgery at the University of Iowa. While with Dr. Smith-Petersen in private practice, Dr. Larson held staff positions at the Massachusetts General Hospital as well as at the Harvard Medical School. His early experience with the sacro-iliac backache and later with Drs. Joseph Barr and Jason Mixter in the field of the ruptured disk stimulated a lasting and searching interest in the problems of backache.

LOW BACK PAIN is a symptom and not a disease. It can and does occur at any age. It is fair to say that backache is a frequent symptom, causes much loss of man-hour labor, is difficult to diagnose as to cause and is in many instances difficult to relieve. It is well recognized that backache is associated with such diseases as arthritis and cancer, commonly follows injuries in industry and in a large segment of the population it occurs unassociated with disease or injury. One difficulty in diagnosis rests in the fact that there is variance in terminology. Another difficulty has been the lack of knowledge of the exact pain mechanisms, pathomechanics and pathologic processes thought to be productive of back pain. At least 53 separate code numbers are given over to diagnoses of backache in the International Code System. This indefiniteness has left the student and average medical practitioner confused and discouraged when confronted with a backache problem.

ACUTE BACK PAIN

A physician will occasionally be called to see a case of backache so acute that the patient is unable to visit the doctor's office

for examination. This may be a first attack or another in a recurrent series. In any case, the essential duty of the doctor is to relieve pain. A quick history will disclose the essentials surrounding the occurrence of the attack and a cursory examination will allow one to proceed with treatment. By cursory it is meant that enough examination should be done to exclude the likelihood of an acute surgical emergency. Spinal cord pressure with impending paralysis and abdominal aneurysm or other acute visceral episode can produce initial and severe back pain; these conditions must be ruled out. If the person can move the legs and feet, has good sensation, no fever, blood pressure change, pulse rise or signs of acute abdomen, it would seem fairly safe to proceed with treatment of the acute backache. The treatment should include medication adequate to allay pain, enforced bed rest and heat to the painful area if the patient can be moved sufficiently to receive it.

Most acute attacks of mechanical origin will be improved sufficiently in 48 to 72 hours to allow a detailed examination. Persistence of acute symptoms beyond 72 hours is highly indicative of some serious underlying process other than ordinary mechanical derangement and hospitalization is mandatory for study to arrive at the proper diagnosis.

CLASSIFICATION OF LOW BACK PAIN

Any cause of chronic or recurring low back pain can also produce an acute attack. Therefore, to continue the search for the cause of acute backache, consideration must be given to all causes of chronic low back pain. The following outline lists the most likely causes that will be encountered. The causes are listed without regard to incidence or frequency but are arranged rather to facilitate differential diagnosis. A quick run-down makes it apparent that a roentgenographic survey of the back will yield findings or lack of them to include or exclude most causes other than mechanical. The salient features of each category will be discussed.

I. *Infections*
   A. Nonspecific (Staphylococcus, etc.)
   B. Specific (Tuberculosis, undulant fever, etc.)

II. *Diseases*
- A. Rheumatoid arthritis
- B. Hypertrophic arthritis (osteoarthritis)
- C. Osteoporosis
- D. Paget's disease

III. *Tumors*
- A. Benign
  1. Hemangioma
  2. Fibroma of cauda equina
  3. Osteoid osteoma
  4. Chordoma
- B. Malignant
  1. Primary—multiple myeloma
  2. Metastatic
     (a) Carcinoma of breast
     (b) Carcinoma of prostate
     (c) Carcinoma of thyroid
     (d) Other visceral primary neoplasms

IV. *Mechanical*
- A. Acute sprains
- B. Chronic strains
- C. Facet syndrome
- D. Degeneration of disk
  1. With instability
  2. With rupture of disk
  3. With foraminal impingement
  4. With secondary arachnoiditis
- E. Congenital anomalies
  1. Spondylolisthesis
  2. Others

V. *Malingering*

INFECTIONS

Although usually considered on the wane, infection, both specific and nonspecific, still occurs in the spine as elsewhere in the body at any age. Most infections of the spine are subtle and do not show the expected constitutional symptoms until well established. To keep them in mind is the quickest way to establish a diagnosis. The severity of pain can be out of proportion to any signs in staphylococcic infection while such signs as x-ray destruction can be severe with minimal pain in tuberculosis. The destruction of contiguous bodies and narrowing of the intervening disk space is the sign of most importance. If in addition to the x-ray findings there are constitutional signs, more specific tests

such as tuberculin, agglutinations for undulant fever and blood cultures early in the course will often give positive diagnosis. Keep in mind in all that the x-ray signs may be slow to develop up to two or three months after onset of symptoms. Bed rest, immobilization of the spine and the proper antibacterial agent is the treatment. Nonspecific infections will ordinarily respond promptly and heal with overgrowth of bone at the margins of the involved interspace. Tuberculosis will be slower to respond and the ultimate treatment will be surgical fusion to ensure and maintain arrest of the disease.

DISEASES

Rheumatoid Arthritis

Marie-Strümpell arthritis, involving the spine, usually begins in the low back and sacro-iliac joints and eventually involves most of the spine ending in the so-called poker spine or bamboo spine. Young males in the late teens or early twenties are by far the most susceptible. It can occur, but is a rarity in females. The onset is slow, with vague aches across the low back. As the disease insidiously progresses there can be radiation pains in the leg or legs resembling the pain of a ruptured disk. Because the symptoms can simulate many other conditions, spondylitis must be kept in mind when investigating causes of backache in any young male. Limitation of chest expansion, limited spine motion and x-ray signs of subchondral atrophy of the sacro-iliac articulations are among the earliest diagnostic signs. In the later stages, 10 to 15 years after onset, the disease is self-evident with a characteristic loss of lumbar curve, stiff spine and a "head forward and shoulders back" posture. X-ray therapy is helpful in controlling severe attacks of pain. Most important, however, in treatment, is to teach the patient to live within the limits of emotional and physical fatigue with enough rest to counter the effects of gravity. In the case where gravity gets the upper hand the spine will be stiff in a bent-forward posture which greatly handicaps the patient. Mechanical support to resist gravity is helpful but is not the complete answer. Cortisone has been found less effective than aspirin.

Hypertrophic Arthritis

The tendency to use and abuse the term "hypertrophic arthritis" is ever with us. This is understandable, since bony overgrowths at the vertebral body margins can and do occur frequently. The mere presence of spurs, however, does not indicate the existence of the disease which deserves a special category, namely, hypertrophic arthritis. To say this in another way would be to point out that injury to one level in the spine frequently results in bony spurring at that level, yet to label this hypertrophic arthritis would be inaccurate. From a pathologic viewpoint the tissues adjacent to a disk respond to any insulting agent by a process recognized as injury and repair. The repair with incident spurring will appear the same whether initiated by infection, local injury or physiologic disk deterioration. We should attempt then to base a diagnosis on the inciting agent rather than the aftermath. Such reasoning will allow us to reserve the term "hypertrophic arthritis" for the recognized entity for which it was intended.

Where the entire spine becomes involved in a degenerative process that shows widespread vertebral marginal osteophytes with progressive pain and restriction of spine motion, certainly the diagnosis, hypertrophic arthritis, can be applied. This is and must be a progressive disease just as it is in the knees, hips or hands which are frequently associated. There is no treatment to arrest the process, and alleviation of symptoms is difficult. Symptomatic treatment with mild support to the back, physiotherapeutic measures and analgesics are helpful.

Osteoporosis

In the population past middle age, back pain, especially in females, is frequently a symptom of osteoporosis. The sudden collapse of a vertebral body during a sneeze or other minimal trauma should put us on guard. The immediate symptoms can be severe, radiating pain corresponding to the level of collapse. Without collapse the back pain will be more likely an ache aggravated by activity and fatigue. The advanced case will show characteristic x-ray signs such as expanded or widened disk spaces

with multiple mild collapse of many vertebral bodies. Less advanced disease will show only a degree of demineralization and coarsening of vertebral body trabeculae. There is no certain method of establishing the degree of density change as visualized in the roentgenogram. Associated findings such as bony tenderness, lack of elastic tissue in the skin, lack of hair growth, and so on, are helpful. Accurate diagnosis can be made only by careful calcium and protein balance studies. A note of warning is imperative at this point. Any spine showing evidence of osteoporosis is a possible case of multiple myeloma, hence myeloma must be considered. A separate discussion of myeloma will be given.

The treatment of osteoporosis is mild support to the spine, maintenance of physical activity to provide stress as a stimulus to bone repair, adequate intake of calcium and protein, use of male and female hormones in small doses over a long period.

TUMORS

Paget's disease as well as the tumors listed in the classification table on pages 4 and 5 will be evident in the roentgenograms of the spine. Differential diagnosis and characteristics of each can be found in textbook sources elsewhere. Two points are worthy of mention here. In the first place, bear in mind that symptoms may be present for as long as two to four months before x-ray changes become apparent. Secondly, the site of back pain may be as much as three levels above or below the site of the lesion in the spine. It is self-evident that discovery of a primary tumor or metastases elsewhere is helpful in the diagnosis of malignant tumors.

Multiple Myeloma

Multiple myeloma commonly attacks the spine and deserves special mention. The symptoms and signs indicating the existence of myeloma can be mistaken easily in many instances for osteoporosis, ruptured disk and for vertebral collapse on a purely traumatic basis. Because of the broad variation of symptoms and signs it must be considered in any backache problem in persons just past middle age and older. If suspected, certain tests are

helpful to clarify the diagnosis. Bence Jones protein in the urine is helpful only if positive. High total serum protein combined with a reversal of the albumin-globulin ratio is indicative of myeloma. Bone marrow biopsy showing excess of myeloid cells and biopsy of any accessible lesion is the surest way to include or exclude the diagnosis. Roentgenographic survey of spine, pelvis and skull is mandatory in any suspected case.

MECHANICS OF THE SPINE

Spinal Curves

The spinal column can best be likened to a flexible pole. It provides us with a means of remaining upright in the biped position. Were it a rigid straight pole it would be more difficult to resist forces that tend to tip the body, so nature has provided curves in the column that can better resist bending forces. These curves are developed in orderly and regular sequence. The spinal column of the newborn forms a continuous bent rod from sacrum to occiput with the convexity backward. The first functional demand on the forward bent spine is a curve to allow the head to be held upward, hence a segment near the head is extended, forming a convexity forward (cervical lordosis). The next functional demand is a change in the forward bent spine to permit a sitting position, thus a curve backward in the lumbar area leaving a convexity forward in this segment (lumbar lordosis). As standing is attempted, the pelvis inclines forward for balance and this is likely to affect all the existing curves in a manner that tends to flatten and broaden them. The result of these functional adaptations is that characteristic physiologic curves persist in the spinal column, namely, cervical lordosis, dorsal kyphosis, lumbar lordosis and pelvic inclination.

Line of Gravity

For the spinal column to remain upright it must be held over the line of gravity. The muscles of the spine and abdomen, by proprioceptive control, constantly adjust where needed to serve as the active balancers to move the flexible spinal column over the line of gravity. There is a great physiologic latitude in rela-

tive length and degree of the spinal curves, yet each curve is compensatory to its neighbor with the result that the line of gravity as it passes upward from the supporting base intersects with all four curves of the spine at certain levels (Fig. 1). Conse-

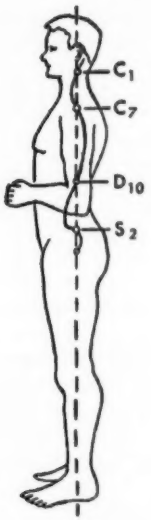

FIG. 1

quently, the body weight is more or less evenly distributed front and back of the line of gravity. The relationship that the line of gravity bears to the curves determines posture so far as mechanics is concerned. Obviously there is some latitude in what might be considered normal posture but in general the line of gravity starts from in front of the ankle, runs slightly in front of the knee joint axis, then approximately through the center of the hip, upward behind the center of the bodies of the lumbar spine, intersects with the spine at the lumbodorsal junction, is in front of the dorsal spine, intersects with the spine at the cervicodorsal junction, is slightly behind the cervical spine and reaches the head behind the ear at the mastoid process.

Stability of the Spine

If a spine devoid of muscles and ligaments except for the disks and their investing tissues were to be held upright by the sacrum, the remainder of the spine would remain in the upright position and resist any efforts to bend it beyond a normal range. This intrinsic equilibrium allows for flexibility with stability and the mechanism should be understood because disturbance of this equilibrium commonly results in backache. Since the spinal column is a series of bony vertebral bodies fixed one to the other through an intervening disk it would suffice to describe one level as representative of all, allowing for a few anatomic differences.

A unit, comprised of contiguous vertebral bodies with an intervening disk maintains stability and flexibility independently of other units. Of most importance is to know the anatomic and physiologic properties of the disk on which rests this responsibility for motion and stability, plus the ability of the spine to distribute and absorb all gravitational and translatory stresses brought to bear on it.

To explain stability it would be well to imagine that contiguous vertebral bodies are pushed apart by an expanding force within the disk. The vertebral bodies are pushed apart until the interbody ligaments are taut and the bodies can separate no further. The disk then maintains this position by its intrinsic turgor. How this is accomplished is only partly known but probably has to do with the water retention properties of the nucleus pulposus. The nucleus confined within the space outlined by the annulus resists compression but a change in shape will occur under compression and, moreover, this change will depend on the elasticity and stress resistance of the confining ligament, the annulus. Hence, abnormality in fluid content of the nucleus or changes in the elasticity of the annulus will eventuate in a disturbance of flexibility and stability of the unit.

The facets, although not so important to the mechanism of stability, are essential as guides for the motions that occur at each disk level. Variations in form and position of the facets accounts for differences of motion in the cervical, dorsal and lumbar areas. In the lumbar region the facets glide as opposing parts of a cylinder surface. This provides axial rotation, flexion and extension

but minimal side motion. Side motion is taken up by the lumbosacral (L5-S1) unit because the facets are arranged more in the frontal plane.

Of all the soft tissues of the spine, the intervertebral disk carries the greatest responsibility for the preservation of the function of the spinal column. The center of motion lies in the posterior portion of the disk and the motion between vertebrae is associated with adaptational changes within the disk.

Pathologic Mechanics of the Disk

Special emphasis is given to the disk because physiologic deterioration so common to this structure leads to mechanical derangements which are productive of backache. This is not meant to exclude the other structures in the spine capable of causing pain but rather to point up the commonest pathologic process and put in proper perspective the so-called "discogenic syndrome" and "ruptured disk." Most of our knowledge of structural changes in the intervertebral disk has been accumulated by combining clinical experience, x-ray signs, operative findings and large-scale study of autopsy material. From the latter there is fair agreement on actual changes observed but these changes must be looked on as effect rather than cause and this leaves etiology for future study. Nonetheless, we can make use of what is known to reconstruct the course of the backaches which might occur associated with disk deterioration.

The following observations are based on fairly solid circumstantial grounds. A normal disk reaches its greatest development at the end of the second decade of life. The aging process begins after the second decade and is a complex, little understood process. It consists of a gradual inspissation of the disk and simultaneous conversion of ground substance of nucleus into cellular formed elements. As stresses are exerted on the degenerating disks, cracks occur in the annulus. These fissures can be concentric, radial or both and can occur at any point. They are found with the greatest frequency in the 4th and 5th lumbar disks. A protrusion of the nucleus pulposus can occur through an annular rent. Motions through the deteriorated disk become altered so that in flexion and extension one vertebral body can move on

another, producing a forward or backward shift. At other times there may be an excessive tilting of the vertebral bodies so as to open the disk anteriorly and close the space posteriorly to produce a much increased disk angle when compared with normal levels. Narrowing of the disk space is common as are osteophytic spurs, which may represent nature's effort at repair. Should these spurs protrude toward the nerve root in the intervertebral foramen, irritation of the nerve root could result. An inflammatory response involving the posterior longitudinal ligament has been observed concomitantly with disk degeneration. Whether this represents part of a repair process is not clear. At any rate, when extensive, it can involve nerve roots by proximity and leave scarring at times with marked fixation of the roots. This finding is usually described as localized arachnoiditis. Secondary changes, including fissures, and cartilage erosions occur in the facets; overriding of facets from disk settling and osteophytic overgrowths at the facet margins are common.

Sources of Pain

In order to clinically pinpoint the underlying pathology in a given backache, it is helpful to recognize possible sources of pain. The disk itself has pain fibers in the annulus and can be painful when under pressure. This is easily demonstrated by the injection of normal saline directly into a disk. Local pain will occur on motion from any structure involved in inflammation such as facets, ligament insertions, and so on, whether the result of degeneration or acute injury. Radiation pain is usual from one or two causes: (1) referred in the true reflex sense and (2) irritation of a nerve root as in protruded disk, foraminal impingement, and so on, in which case the pattern of pain is likely to be true dermatome distribution. Secondary pains occur in muscles that are or have been in spasm as part of the protective mechanism.

Acute Back Sprain

A sprain by definition is a tear of a supporting structure and in the spine it would involve the ligaments, capsules and fascial planes. Tears can occur only when movements have exceeded the

physiologic range allowed by these check-rein structures. Two common causes are: (1) sudden forward flexion as might occur in a fall when a person slips on ice and (2) sudden increased load while lifting in a stooped position such as might occur when holding one end of a heavy beam that is dropped. Often this is referred to as a sprung back. Examination within 48 hours will reveal protective muscle spasm, painful pressure point and motions of the spine limited in all directions, particularly that motion which occurred during the injury. X-ray films will be negative unless the force of injury was sufficient to cause fracture or dislocation in which case the latter will become the diagnosis. Most sprains will heal in three weeks if protected against excessive motion and extreme positions. The prognosis is good for return to previous occupation.

Chronic Low Back Strain

This diagnosis if applicable whenever the examiner can conclude from the history and findings on examination that a particular supporting structure has been subjected to tension beyond its physiologic capacity to withstand it. As this occurs there may well be microscopic tears as well as attritional changes in the tissues under tension, both of which call forth inflammation incident to repair and this more than likely is the source of pain. Myofascial strain, a frequently used diagnosis, may well fit into this category since the muscles of the back and abdomen will often reflexly protect a painful area against motion and can become painful in themselves when maintained under excess tension for long periods. Causes for low back strain vary from occupational attitudes to poor posture. The history of the patient is helpful in that the straining incident may be suspected by him, the discomfort is slow in onset, progressive, aggravated by fatigue, more or less relieved by recumbency, heat and massage. Spinal movements ordinarily remain normal except where there are contractures such as a fixed lordosis. In this event the examination will elicit or reproduce the pain when the strained structure is placed under further tension, i.e., lordosis places strain on the anterior longitudinal ligament, hence if the ligament is passively stretched by further hyperextension, the original pain is repro-

duced and the strain is localized. X-ray examination may show ossification or calcification at the insertions of the ligaments strained. In long-standing strains it has been pointed out that increased density of the bony margins will occur. This interpretation of roentgenograms is risky since bony overlaps are easily mistaken for increased density and should therefore be carefully evaluated. The treatment of this group of backaches will be directed toward elimination of the strain-producing act when ascertained. Contractures should be stretched and support given to oppose the position of strain. The prognosis is guarded and is dependent mainly on the physician's ability to ferret out the cause, and the patient's willingness to co-operate.

Facet Syndrome

For lack of a better terminology, facet syndrome refers to a collective set of symptoms and signs which occur frequently and deserve special discussion. The typical example is an acute sudden catch in the back which freezes the person into a fixed position from which he cannot move. Usually this happens in the stooped-forward position and the person cannot straighten. The severe acute pain is ill localized across the low back without radiation and can be dramatically relieved by manipulation. A soreness will persist for three to four days and between attacks there is no discomfort or limitation. The orthopedic surgeon commonly will see this patient after ten years of repeated attacks when manipulations fail to relieve the symptoms; then the attacks increase in frequency and each lasts longer until they all but merge into continuous backache. Examination is impossible in the early attacks because of severity of pain. Between attacks examination reveals nothing and x-ray examination commonly will show only an asymmetry of the lumbosacral facets. This latter circumstance has incriminated the facets as being in some way responsible or related as a causative factor. What actually happens to produce these attacks has never been demonstrated. After ten years, however, the same facets will show thinning of the joint space, marginal sharpening and osteophytic overgrowths indicative of a degenerative process. This is incriminating evidence that the facets have been involved, if not the direct cause of the attacks.

In my experience the attacks can be cured by simple bed rest and heavy sedation in the same length of time as by manipulation with the added advantage that the facets are not forcibly moved one on the other while under the compression influence of intense muscle spasm. It is conceivable that the bed rest type of treatment could reduce the amount of traumatic arthritis of the facets. More importantly, these patients should be strongly advised to refrain from stooping so as to prevent attacks. Once secondary changes in the facets or the disk itself have occurred, more strenuous therapeutic measures are necessary.

Backaches Incident to Degeneration of the Disk

A general discussion of this group of backaches will help us to understand the main problems and better visualize the specific categories. The Munkfors investigation has shown that 80% of industrial and forest workers complain of pain referrable to the back or neck or both. Accidents accounted for only 20% of the lumbago/sciatica syndrome while an additional 20% gave a history of strain such as heavy lifting. Evidence of disk degeneration (osteophytes and/or narrowing) increased with age so that at 59 years, 90% showed evidence. The incidence of these changes was somewhat higher in those engaged in heavy work. Disk degeneration developed and attained advance stages in some without corresponding history of low back pain. It was the conclusion of the investigators that disk degenerations in themselves were not productive of symptoms until changes secondary to the degeneration occurred, such as herniation of the disk. These secondary changes seemed to occur by chance and often without apparent reason. Such factors as infectious disease, dampness, drafts and certain forms of hard labor played a provocative role. On the other hand, static deformities such as pelvic tilt, lordosis, kyphosis and flat foot were of no significance. Lumbarization, sacralization and asymmetric fifth lumbar vertebrae did not exhibit an increased tendency to low back trouble. Spondylolisthesis was the single anatomic derangement that did show higher incidence of back trouble as well as x-ray evidence of disk degeneration.

To summarize, degeneration of the disk is physiologic, begins

PLATE 1.—Incidental x-ray. No history of backache. Shows disk space at L5 of fairly good height.

at the age of 20, shows increased incidence among heavy workers, is associated with injury, aggravated by dampness, drafts and intercurrent infections. It can be extensive without a corresponding history of back pain but most often is associated with back pain which occurs in attacks that become chronic and continuous. Leg pain and/or sciatica is frequently an added symptom in this group and the history of back and leg trouble often extends over a period of months to years.

Since degeneration is likely to be progressive once it is initiated, it is understandable that the clinical picture can change from time to time. Furthermore, we know from clinical experience that symptoms can be relieved at any stage, either spontaneously or by treatment. It is assumed that nature can repair the abnormal tissues by fibrosis but this is assumed by analogy and has not been definitely demonstrated. For our discussion we will assume that some measure of tissue repair occurs up to a point but we must admit that the length of time necessary for healing is unknown. In simple words, we cannot predict how long it will take a given stage of degeneration to heal or to become symptom free. We do not know the natural course of degeneration and therefore cannot give accurate prognosis. It is for this reason that varied opinion will be given in the same case since each examiner must base an opinion on his own experience. We can begin to recognize certain stages of degeneration such as disk instability, rupture and secondary nerve involvement which we will designate as arachnoiditis and foraminal impingement. These stages, if distinct, are more predictable as to outcome and therefore will be described individually.

EARLY DEGENERATION OF THE DISK.—It has already been stated that physiologic deterioration of a disk can occur without symptoms and when symptoms arise they are the result of secondary changes incident to deterioration. These secondary changes are difficult to demonstrate in early degeneration and therefore the diagnosis is difficult and often can only be surmised. The diagnosis is further obscured since chronic ligamentous strain, faulty posture or structural defects co-exist, in fact enhance the disk deterioration and in themselves overshadow the real issue.

While the onset of back pain in early degeneration may be

PLATE 2.—Same patient as Plate 1 10 years later with first attack of pain. Note narrowing of disk space at level of spondylolisthesis.

variable, it is likely that minor strains will start the first attack. The pain across the low back comes on after a sudden stoop, sustained stoop, lifting, long automobile trip, sudden twist or slip or may follow a fall. Characteristically the pain begins some hours after these incidents, which tends to rule out ligamentous strain. The pain then builds in intensity for several days and slowly subsides in two to three weeks. Such attacks occur once or twice a year, occasionally require bed rest and seldom lead to medical consultation. Each succeeding year the attacks occur more frequently, are of greater intensity and last longer, and when the inciting incidents become so trivial as to escape notice by the patient, he grows concerned sufficiently to seek medical aid. Examination at this time is often of little help except to localize tenderness in the low back. Roentgenograms will at the most show equivocal narrowing of the disk space but will be helpful to rule out diseases that involve bone. A positive diagnosis is untenable so at best a working diagnosis of early degeneration is permissible. Treatment at this stage has a real value inasmuch as symptoms can be controlled and often subsequent attacks prevented. This is the time to point out to the patient how to use the back properly to avoid mechanical insults. Support may be helpful to safeguard against strains, at least until exercises have established stronger than normal active support. Manipulations are to be avoided and no known drug therapy will hasten or assure arrest of the degenerative process.

DEGENERATED DISK WITH INSTABILITY.—When a normal disk has lost its intrinsic expanding force it settles or narrows and this alters the usual mechanics in two ways. In flexion and extension, the rocking mechanism of the normal disk is lost and a shifting motion is substituted. In forward bending the vertebra above will shift forward on the vertebra below. In backward bending the vertebra above shifts backward on the vertebra below. These shifts are demonstrable in lateral roentgenograms taken in flexion and in extension. More commonly a second type of instability may be demonstrated in lateral views of flexion and extension. The disk opening is abnormal compared to other levels; for example, in extension the disk narrows in back and opens in front to form an angle that will exceed the angle of the normal disks. Discograms have verified the fact that degeneration is present

and productive of pain in the two types of disks described above.

Instability can be suspected on clinical grounds. The history will be that of a persistent backache, often with radiation of pain into one or both buttocks, indefinite vaguely localized aches in both thighs, aggravated by stooping or twisting and by sitting in soft, deep chairs. Seldom will coughing or sneezing bother but sudden motions are avoided. Examination will reveal local interspinous tenderness maximal at the level involved and the instability test will be positive. Neurologic signs are ordinarily normal. The x-rays will show the abnormal disk motions with or without narrowing. Treatment will consist of back support and teaching the patient proper back mechanics to avoid positions of strain. Progressive resistance exercises for the back and abdominal muscles are started when the patient is free from spontaneous pain and this is ordinarily six to twelve weeks after initiating treatment. I would estimate that 60% of this group will be symptom free, working and not dependent on a brace in one year. The remainder may take longer and a certain group, perhaps 15%, will require further help in the form of operative fusion.

DISK DEGENERATION WITH PROTRUSION AND/OR RUPTURE.—"Ruptured disk" is a common household term and is likely to be used to designate backache with sciatica from any and all causes. A ruptured disk must be considered a complication of a degenerated disk since experimentally it is difficult to produce a rupture of a normal disk.

The clear-cut case begins with a backache across the lumbosacral area that goes away after a few weeks only to recur at intervals until it becomes a nagging backache which forces restriction of physical activity. At this stage it is identical to what has been described as early degeneration of the disk. Rather suddenly, often while lifting, there will occur twinges of pain in the leg which in a matter of days become constant and spread from the buttock area down the posterolateral thigh to the lateral calf and into the foot. The leg pain masks the back pain so that it dominates the complaint and is of a dull aching type. Sciatica, although anatomically an incorrect term, disturbs sleep, is aggravated by sudden jarring movements, coughing and sneezing and relieved a little by shifts to certain positions. Often the patient must get out of bed and move about to find a measure of relief.

Examination will show a person who cannot straighten into good posture but prefers to stand with the knee bent on the painful side. Forward bending and bending to the side of pain will reproduce the sciatica. Backward bending may do the same and more certainly will produce pain in the back. Straight leg raising on the painful side may be limited often to 20 to 30 degrees. Neurologic signs including leg atrophy, reflex loss, weakness of anterior muscle groups which dorsiflex the foot and toes and sensory discrepancies over the 4th or 5th lumbar dermatomes in the leg will be present in toto or in combinations. The low back will be tender in varying degrees at the level of the protrusion, and the instability test may or may not be positive. X-ray findings range from normal to degrees of disk narrowing with occasional spurring and/or instability shifts. A filling defect in the myelogram corroborates the diagnosis and establishes the exact level. The indication for surgical removal of the ruptured fragment seems clear and indeed the removal of such fragments gives dramatic and prompt relief of the sciatica. Conservative management in many cases will also bring about relief of symptoms. Should the response to bed rest be one of continuous improvement, it would indicate a pathologic process more reversible than a free fragment and in this event the treatment should continue conservatively on the same basis as described under the heading "Degenerated Disk with Instability."

DEGENERATION OF THE DISK WITH FORAMINAL IMPINGEMENT. —This is a late stage of disk deterioration and the x-ray findings are helpful in making the diagnosis. Impingement may be suspected when the pain becomes more or less continuous, consistent in location and follows a true dermatome distribution. It is true that such activity as stooping and twisting will aggravate the pain, yet rest will improve but not completely relieve the pain. There will likely be neurologic signs such as positive straight leg raising, mild reflex changes and paresthesias over the involved dermatome. Examinations of the spine itself may show nothing more than restricted motion and no tender points. X-rays will show bony overgrowths projecting into the intervertebral foramen and these can originate from the posterior margins of the bodies, from the facet margins nearest the nerve sulcus within the foramen or both. These changes will be best visualized in

roentgenograms taken obliquely to show the foramen. To relieve the pain it will often be necessary to decompress the nerve by operation. If the patient wishes conservative treatment, a back brace to hold the back in the position of comfort may be helpful. Avoidance of any activity likely to produce symptoms will cut down irritation edema about the impinged nerve root and diminish thereby the severity of pain. Other measures such as aspirin, gentle heat, and so on, may keep the symptoms tolerable.

DEGENERATION OF THE DISK WITH ARACHNOIDITIS.—The most distressing sciatica associated with backache is that group in which the nerve root or roots become involved in the pathologic process associated with disk degeneration. Fortunately, the incidence of nerve root scarring and fixation is not great. It is likely to occur where the disk degeneration has been rapid and the backache severe. The sciatica is intense, persistent and associated with neurologic signs. The signs persist and at times progress slowly over a period of weeks or months and this sets it apart from the usual ruptured disk with sciatica where the nerve signs appear early and are not so progressive. The final differential diagnosis will be confirmed only by findings at operation. One or more nerve roots will be bound to the canal by adhesions, there may be inflammatory granulations about the nerve and in severe cases where the nerve sheath is opened the nerve fibers will be found firmly fixed to the sheath and to one another, hence the term arachnoiditis. The underlying disk may lead one to suspect that some degree of rupture had occurred in the past because of secondary changes observed such as bony ridges, narrowing, thickened, overlying longitudinal ligament and occasionally an ossified mass in the location where protrusion would have been likely.

There is some question whether operative treatment will accomplish more than conservative management. It seems reasonable that decompression and freeing of the nerve root will speed up recovery but the risk is that the adhesions may recur to a point of obviating any operative gain. From my own experience, I would favor operative management followed by exercises to maintain mobility of the nerve root. In any event, the outcome of this type of involvement is unpredictable so the prognosis must be guarded.

Operative treatment of degenerated disk with rupture. —Operation for the relief of pain in a ruptured disk has a definite place in the treatment of backache. The indications are clear: (1) if demanded by the patient for the relief of pain and (2) when neurologic signs are severe or progressive. The operation is done by either an orthopedic surgeon or a neurosurgeon, dependent mainly on whether either is available in any given community. There are variations in technic but in general a hemilaminectomy of adequate size to gain access to the disk space is standard. Free disk fragments are easily removed and as much of the remaining disk tissue from the same level as possible. Nerve roots are freed of tension and made mobile. With the operation completed there is frequently a question whether spinal fusion should be added to stabilize the level.

Two distinct philosophies exist regarding postlaminectomy fusion. Those for fusion quite rightly point out that the remaining disk is unstable and should therefore be stabilized. Those against fusion point out the high incidence of pseudoarthrosis of fusions and further believe that settling of the remaining disk space is necessary before healing can occur. Many statistics are available to show evidence in favor of both philosophies. My own experience has been that subsequent rupture can occur whether fused or not and fusion makes a second exploration quite difficult. For this reason, I have reserved fusion as a later operation and have found it necessary in only a small percentage of cases.

SPONDYLOLISTHESIS

Approximately 5% of spines will show a defect of the pedicles and what appears to be a forward slipping of the corresponding vertebral body on the one below (Fig. 2). This is called spondylolisthesis. The defect of the pedicle, referred to as spondylolysis, is either congenital or the result of faulty early development and can occur without spondylolisthesis. It is well recognized that spondylolisthesis can exist without symptoms of backache; therefore, the spondylolisthesis of itself is not painful. Secondary changes are most likely to bear causal relationship with backache whenever spondylolisthesis becomes painful. Degeneration of the disk is the likely secondary change (Plates 1 and 2), although

others have been described such as excessive looseness of the laminal arch, rudimentary facets and excessive cartilaginous callus at or near the defect in the pars interarticularis. In the event of deterioration of the disk the symptoms and signs will be identical with the degeneration and secondary changes already described for any disk. The treatment likewise should be directed at the

FIG. 2

disk rather than the spondylolisthesis per se. Only when conservative measures have failed to allow the degenerated disk to stabilize will spinal fusion be necessary. The same philosophy holds for all other congenital defects of the lumbosacral spine.

MALINGERING

A few suggestions may be in order. Inconsistency of findings, widespread tenderness, lack of fit between objective and subjective signs and symptoms, and so on, certainly should put one on guard. The benefit of the doubt, however, should demand repeat examination and additional corroborative evidence. Variation in straight leg raising from one body position to another, changes in signs by distraction of attention, duplication of tests in reverse

order will help pinpoint presence or absence of equivocal signs. Where interspinous tenderness is present at several interspinous spaces in the dorsal spine, this is frequently a real finding in long-standing low back pain and the patient is not aware of this until examined. When this finding is present it would tend to rule out malingering. Actually malingering is quite rare and a much more difficult evaluation is the degree of organic involvement in persons who are apprehensive and likely to exaggerate. I know of no rules to apply to the latter except to base a diagnosis and prognosis on the presence of objective signs and not on their quantitative intensity.

CONSERVATIVE TREATMENT OF LOW BACK PAIN

Williams, Hauser and many others have described in detail a program of conservative management to relieve low back pain. They vary in detail pertaining to type of brace and type of exercise, yet they tend to follow the same general principles. Perhaps this is the time to present a simplified composite of conservative therapies that can be applied to all low back pain, exclusive of those associated with specific disease.

The most important role of the physician is to gain the confidence of the patient so that whatever is agreed on, the patient will co-operate. Herein lies the art of the practice of medicine, and no matter how experienced the physician may be, failure of co-operation will prevent application of the science, and treatment becomes a lost cause. Two important issues dominate the patient's thinking—first, what is wrong with his back and, secondly, what can be done about it. Confidence will be established if the doctor will take the time to explain in simple terms what he thinks is wrong with the back, what can be done about it and then let the patient know that a large share of success will depend on how the orders are carried out. This places responsibility on the patient which in the long run will win since a cure cannot be handed to him on a silver platter.

Demonstration by the use of photographs, x-ray films or a model spine is invaluable to help the patient visualize his problem. He can be shown readily how mechanical factors play a role both in cause and in treatment. I have found simple dia-

grams helpful to show the correct mechanical use of the spine to be applied in everyday living.

In standing it seems natural to slump and in doing so each curve of the spine has to increase until the slack is taken up in all the ligaments. If this extreme position is maintained, it can in itself cause pain just as in the case of pushing a finger back to the extreme and holding it there (Fig. 3). With practice, one

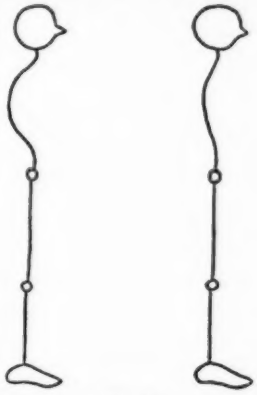

FIG. 3

can learn to flatten the lumbar spine (eliminate swayback) by tucking the tail under, holding the head high with chin in and leaving the shoulders in whatever position they feel relaxed. The patient should be taught this posture and should practice holding it for a second or two fifty times a day until it becomes a habit.

Stooping should be avoided for a simple mechanical reason. The weight of the body from the nose to the tip of the coccyx comes to rest on the lumbosacral junction as a fulcrum and certainly this must aggravate as well as prevent healing of any pathologic process present, especially if repeated frequently (Fig. 4). This can be corrected easily by bending the hips and knees each time the body is inclined forward and this shifts the fulcrum to the hips. To apply this as in the daily task of brushing the teeth, the patient need only to place one foot on a bath stool

before stooping and this makes it mandatory to bend forward on the opposite hip, hence removing the strain from the lumbosacral area.

Sitting correctly reduces strain on the lumbar spine as evidenced in the simple diagram (Fig. 5). When one sits in a soft, deep chair, one has to sit incorrectly; therefore, such chairs should be avoided. Automobile and theater seats tend to incline backward and one may think he is sitting straight but the lower

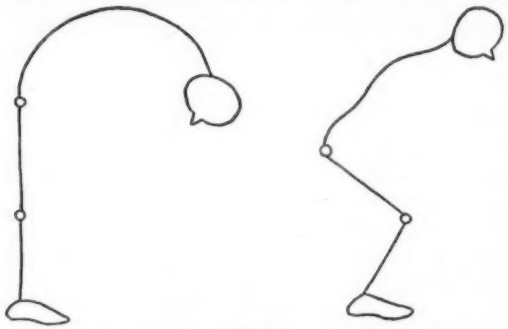

FIG. 4

lumbar spine flexes and this position maintained for long periods causes strain and pain. To relieve this is to prevent it by the addition of a small pillow crosswise in the hollow of the back at the belt line. In the theater the proper type of lady's purse with the usual contents makes a good support.

A low back brace is useful to act as a reminder for the patient to use the spine correctly. The brace is a reminder rather than a support and, in addition, it gives the spine a guide to the new positions to be acquired. This is necessary since few people have any voluntary proprioceptive control of their own back positions, hence these must be learned. A brace used in this way causes little loss of muscle tone or strength and can be discontinued whenever the patient can consciously or automatically control positions. The combination of brace and correct use of the back accomplishes two things: (1) it avoids positions of strain and (2) it reduces the motion at the lumbosacral junction and thus

provides rest for the part, which in turn allows for healing.

The patient's bed should be firm to prevent sway or sag. A horsehair, cotton pack or coil spring (stiff, small and many) mattress on a good box spring is satisfactory. A little give in the mattress is comfortable to the bony prominences. A severe fixed lordosis will be uncomfortable if the bed is too rigid because the arch, in trying to reach the bed, is kept at an extreme position when compared with the normal. Gentle heat as furnished by

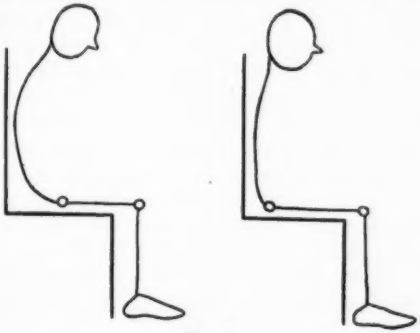

FIG. 5

an electric heating pad for 30 minutes at bedtime gives muscular relaxation, as does gentle massage if available. Aspirin two or three times a day and periods of recumbency during the day help to prevent the fatigue aches which occur in any overworked muscle.

Ambulatory patients who can understand and intelligently carry out what has been described will show week-by-week improvement which encourages them to continue the treatment. Ordinarily, in two months those who are going to respond will have improved so that exercises can be started.

To determine the effect of exercises on backache, the author directed an investigation over a three-year period and two conclusions were reached. In the first place, it was found that the normal average ratio of back to abdominal muscle strength was 3:1. In cases of backache this ratio was disturbed and most frequently the disturbance was in the direction of weak abdominals.

Exercises eventually were designed to restore the ratio to something approximating normal and with few exceptions the back pains disappeared when this was accomplished. Any exercise program, then, should have in mind the building of muscles in the back and abdomen to bring about an improved ratio. From a practical point of view this is not difficult and can best be done by progressive resistance exercises as described by DeLorme. These must be taught the patient and he can carry them out at home. If they are in any way painful it is either too early in the course of healing to have started them or they are being done incorrectly. By trial and error a method should be found whereby the exercises are not painful or they should be discontinued.

The total outcome of conservative measures will bring about the recovery in a majority of the mechanical disorders to a point where the patient is satisfied to carry on without surgical intervention. He will need to be heedful of what he has learned for a number of years. Should he slacken his habits and face a recurrence of pain, the same routine of treatment may be reinstated with the same anticipated recovery. Some will not be relieved by conservative means and the decision for surgical intervention must be made after careful re-evaluation and consultation.

EXAMINATION

The pertinent findings in any examination of the back can be quickly observed if the examiner knows what he is looking for. To be able to reproduce the symptoms in the course of examination is the most helpful means to pinpoint the source of pain since the examiner can visualize the specific structure under tension. If the symptoms cannot be reproduced it is unlikely that they arise from the spine and this fact will point up the case which needs further investigation of pelvic organs, kidneys and so on.

Standing

The entire spine must be visualized to note any obvious deformity such as gibbus and to evaluate the posture. The anterior superior spine of the pelvis is ordinarily one to two fingerbreadths

below the level of the posterior superior spine and deviation from this indicates a spine the center of gravity of which is excessively in front of or behind the line of gravity. A protective list, scoliosis or antalgic position will be obvious.

Flexibility

The normal spine as it bends forward will form a continuous curve from the sacrum to the occiput and any deviation such as failure to reverse the lordosis is noteworthy. This could be due to pain or to fixed contracture. Ability to touch the floor in forward bending is of little value since normal spines with short ligaments and tight hamstrings are unable to do so. Pain on forward bending is hard to evaluate since all ligamentous, muscular and disk tissues are under tension or compression. However, forward bending will not be painful in the case of kidney or pelvic pathology. Side bending should be symmetrical; if pain occurs on the left side in left lateral bending the source of pain is from compression whereas pain on the right side in left lateral bending is from structures under tension. Backward bending does three things—it stretches the anterior longitudinal ligament, settles the facets to the maximum and compresses the posterior portion of the disk, hence pain could arise from any of the three sources. Muscle spasm is difficult to recognize in the standing position since active contraction is necessary purely for balance.

Lying on Back

Measures necessary to ensure comfort of the patient in this position should be taken, since discomfort evokes protective spasm which will obviate objective signs. The most important test is straight leg raising and this gives important information relative to nerve root pain. Be certain the test is entirely passive and begin by grasping the leg at the ankle with one hand, keeping the knee extended with the other hand. Elevate the leg slowly and stop when the patient complains. The act of straight leg raising actually places the nerve roots of the sciatic nerve under tension; therefore, this test is sensitive if one of these nerve roots is already under tension as in the case of ruptured disk or other

space-occupying lesion in the canal. Often at 20 to 30 degrees elevation the entire symptomatology including leg radiation pain will be reproduced. If dorsiflexion of the foot is added, the reproduced pain becomes exaggerated as further evidence of true radiation pain.

Strength of the abdominal muscles can be tested in this position. The patient attempts to sit up without using the hands while the examiner gives leverage advantage by holding the patient's knees to the table. It is normal to expect anyone to be able to do this so that inability to do so indicates weak abdominal muscles unless pain prevents the test.

Lying on Abdomen

A pillow under the abdomen may be necessary to obtain a comfortable, relaxed patient. The examiner makes a search for tender points in an effort to localize the cause for the back pain. Interspinous tenderness anywhere in the spine is noteworthy. The pressure necessary to elicit tenderness should be less than that which transmits movement to the spine. Any muscle in spasm will be tender and is therefore not helpful to the localization of pain. Similarly, muscle insertions as along the iliac crests, lateral borders of sacrum and iliolumbar angles are commonly tender but are to be considered as secondary to protective spasm and not of primary concern. Occasionally, trigger points will be tender and when pressed on will likely give referred pain of which the patient has complained. This finding is also of secondary importance and does not help to localize the pathologic lesion.

The instability test has been worked out to detect abnormal disk mobility. This is carried out by pressure exerted downward on an individual spinous tip, using the heel of the hand as the pressor. In essence, this is a passive extension test applied individually to each level of the spine. When a level pressed causes the patient's original pain to be reproduced, and this pain disappears as the patient simultaneously actively extends the spine, the test is considered positive. When correlated with the x-ray findings the author has found this test as reliable as any other to detect disk degeneration and it serves the same purpose as the discogram.

Neurologic Examination

A routine part of any examination are the following neurologic tests. The reflexes at the knee and ankle, measurement of the calves for atrophy, muscle strength of the toe extensors as well as dorsiflexors and evertors of the foot and a mapping of any sensory discrepancies in the leg and foot are all of value in localization of the level and extent of damage to nerve roots. Spinal puncture and myelogram should certainly be done if cord tumor is suspected as a differential diagnosis or where more evidence is needed to detect the presence and location of a suspected rupture of the disk. It would seem unnecessary to do myelograms as a routine procedure when clinical signs in themselves are diagnostic.

X-ray Examination

Roentgenograms are imperative. The routine anteroposterior and lateral views will reveal disease such as metastatic tumors, primary tumors, Paget's disease, anomalies, and so on. Additional views in flexion, extension, right and left obliques are necessary to detect instability shifts, foraminal osteophytic impingements and facet changes.

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